RAIN GARDENS

Corkran Middle School Rain Garden
Anne Arundel County Public Schools

Case Study: Rain Gardens

More than 300 seventh graders at Corkran Middle School, Anne Arundel County, participated in a Service Learning Project to create the school's "Rain Garden." The project transformed an interior grassed courtyard into a beautifully landscaped stormwater treatment system that slows down, filters, and removes pollutants from runoff before entering the Chesapeake Bay.

The project was funded by a $1,000 grant from the Chesapeake Bay Trust with each student contributing more than 10 hours on the project. Art students were responsible for the design of the garden, while math students measured and made scale drawings. Language arts classes wrote articles for the school newspaper and social studies classes raised funds to build benches and bird houses. The science students were responsible for the majority of the labor: tilling the soil, planting the shrubs and wildflowers, spreading mulch, watering, and weeding.

The rain garden retrofit project was a cooperative effort with many participants including the Maryland Department of Natural Resources, Chesapeake Bay Trust, Save Our Streams, Prince George's County Department of Environmental Resources, Connector Corps, students, and faculty.

The project participants were honored and praised by local government and school officials, environmental groups, and environmentalists.

"You have created the first rain garden in Anne Arundel County, putting Corkran Middle School on the cutting edge of Bay restoration technology," said Ron Gardner of the Department of Natural Resources.

"You have contributed to the beautification of your school and the restoration of the Chesapeake Bay. You should be very proud," said Karina Shipps of the Connector Corps for Service Leaning.

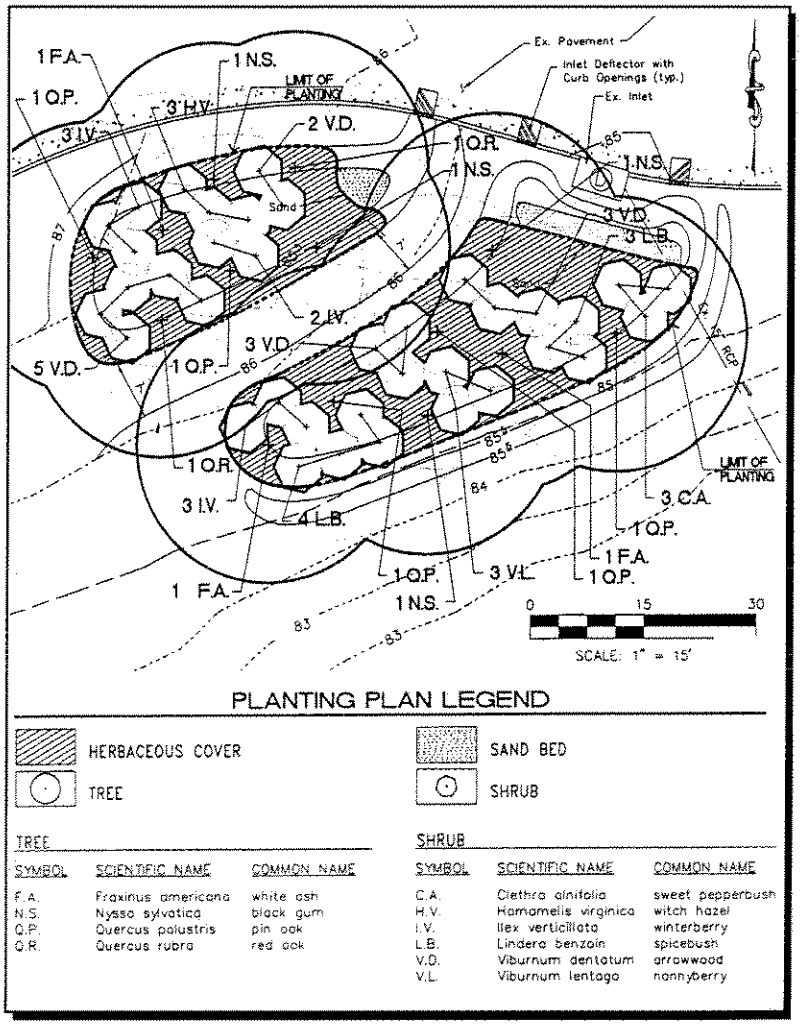
"It has been so encouraging to see the students accomplish this project with such interest and enthusiasm. It is amazing to see how much the students care about and take pride in the rain gardens that they created to protect the environment," said Peggy Sange, Corkran Middle School, Enrichment Teacher and Project Coordinator.

Rain gardens combine hydrologic and environmental benefits with the aesthetic and habitat values of landscaping. Depending on mitigation needs, type of application, plant materials, and site constraints, rain gardens can effectively remove pollutants from runoff, promote ground water recharge, restore watershed hydrology, enhance terrestrial habitat, provide shade to reduce thermal impacts, and improve aesthetics. Monitoring results have shown excellent pollutant removal rates of 60% to 80% for nutrients and 93% to 99% for heavy metals.

Environmental Enhancement

Rain gardens are simply very shallow (2" to 6" deep) landscaped stormwater runoff storage areas. Runoff is captured in these low lying areas to be infiltrated or filtered, allowing the soil and plants to uptake, transform, and remove pollutants. Rain gardens are not wetlands. They are designed to drain quickly allowing the use of typical landscape plants. The technique allows landscape and green space to be designed to serve many functions including stormwater management, aesthetics, habitat, and environmental protection. Using the landscape to treat stormwater runoff may reduce the need to use costly conventional stormwater management devices.

Rain gardens are designed using the principles of bioretention, a water quality practice in which plants and soil remove pollutants from stormwater. Bioretention is an alternative cost effective practice that allows the use of landscaped features to achieve runoff controls. Rain gardens are integrated into and uniformly distributed throughout a site's forested areas, green space, drainage swales, streetscapes, median strips, or parking lots. The term rain garden implies the use of bioretention measures in a highly visible area where a more aesthetically pleasing (garden like) design is desirable.



Typical Planting Scheme for a Rain Garden Figure 6

Rain gardens are modeled after a terrestrial upland soil/forest composed of native upland trees, shrubs, and herbaceous plants. This system is not dependent on a constant source of water thereby reducing the need to destroy additional riparian forest or wetland areas by building conventional stormwater ponds.

Rain gardens maximize the use of physical, chemical, and biological pollutant removal processes to treat runoff. They are small models of natural forest ecological systems that demonstrate how the landscape functions to protect the integrity of a watershed's aquatic and riparian ecosystems. Their designs also demonstrate the interconnections of a wide array of environmental and engineering principles and disciplines including the hydrologic cycle, nutrient cycles, biology, forestry, soil chemistry, ecology, horticulture, and landscape architecture.

Planning, Design, and Construction

Key factors in the design and construction of rain gardens are careful selection of plant materials that can tolerate extreme hydrologic changes, good drainage to prevent creating anaerobic conditions, safe conveyance of overflows, careful use, inspection and control of backfill soils and careful inlet/outlet controls to prevent erosion.

Rain gardens consist of a shallow ponding area (6" deep or less), mulch layer, sandy planting soil, plant materials and, where appropriate, the use of under drains. The design can vary greatly to accommodate site constraints, ground water recharge, soils, habitat/ ecological objectives, watershed hydrology, and aesthetics. The facility must be well drained by infiltration (where soils allow) or by under drains or both. Stored water runoff soaks into the ground over a period of less than a day into the underlying soils or to an under drain which discharges to a swale or pipe.

Specific configurations and locations of the rain gardens are determined after site constraints such as location of utilities, ground water level, steep slopes, underlying soils, existing vegetation, and drainage are considered. Where soil infiltration rates are lower than 1 inch/hour or in order to extend the life of the rain garden, under drains should be used to ensure good drainage.

The drainage area for one rain garden should generally be between 0.25 and 1 acre. Multiple rain gardens are needed for larger drainage areas. The storage volume of the rain garden will be determined by the desired level of control (e.g., first half inch of runoff) and de-watering capabilities of the design. Rain gardens work best when there are many facilities with small drainage areas. Large facilities with large drainage areas tend to allow soils to remain saturated for longer periods creating poor drainage conditions, stressing the plants, and reducing the pollutant removal effectiveness.

The maximum ponding depth of the bioretention area should be 6 inches. This depth provides for adequate storage and prevents excessive ponding periods. Water ponding for longer than three days restricts the type of plants that can be used and may encourage mosquitoes to breed.

A minimum planting soil depth of 2 feet is recommended. This depth will provide adequate soil for plant root systems and soil reactions to remove pollutants. Planting soil should be lightly compacted until the desired depth is reached.

Planting soil should be sandy loam, loamy sand, or loam texture and have clay content of 10 percent or less. The pH of the soil should be between 5.5 and 6.5. Pollutants (e.g., organic nitrogen and phosphorous) can be absorbed by the soil and microbial plant activity can flourish within this pH range. The planting soil should contain 3 to 5 percent organic content.

Native species of plants are recommended because they are tolerant to the regional climatic, soils and hydrology. The designer should assess aesthetics, site layout, habitat objectives, and maintenance requirements when selecting plant species.

After placing the trees and shrubs, the ground cover and/or mulch should be established. Ground cover such as grasses, legumes, or flowers can be used. Two or three inches of commercially available fine shredded hardwood mulch or shredded hardwood chips should be applied to provide erosion protection.

Specific Design Applications and Modifications

Rain gardens have a wide variety of applications. However, the designer must carefully consider the unique problems presented by each application.

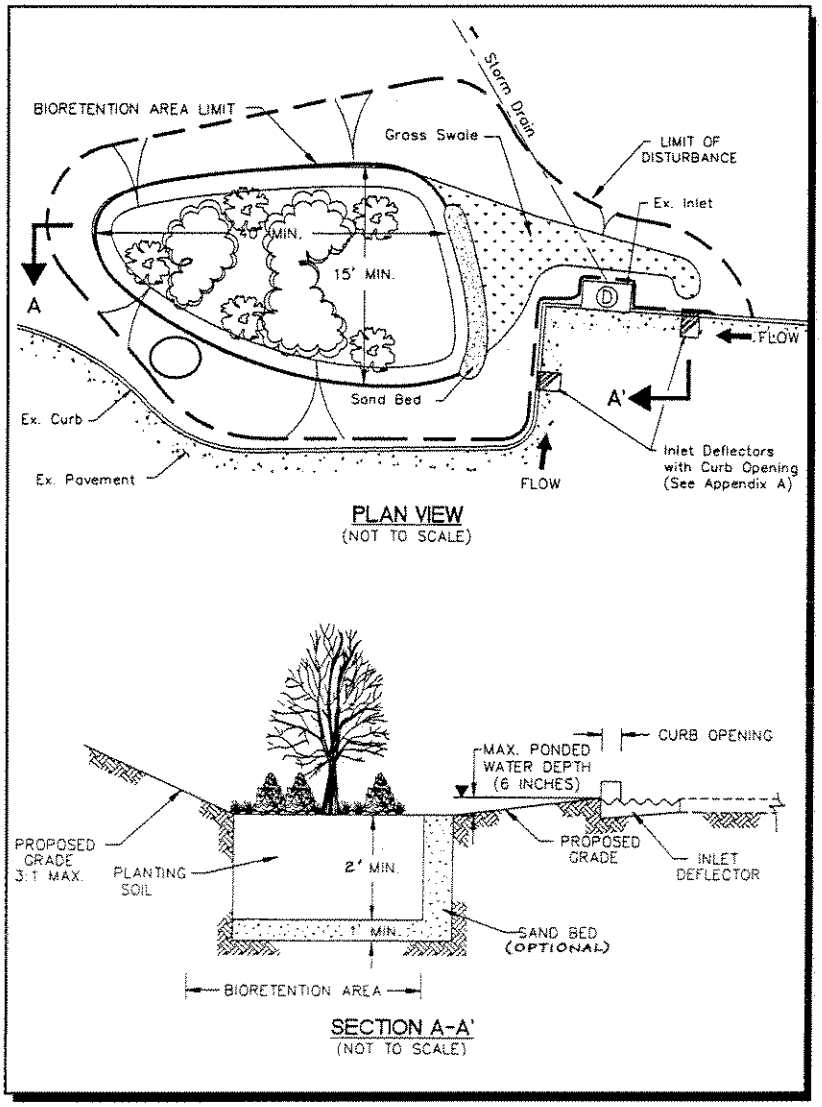
Parking Lot Islands, Median Strips, and Formal Landscape Islands Around Buildings - Care must be taken to ensure that infiltration and ground water seepage will not adversely affect the structural integrity of roadways or buildings. The careful attention to grading, location, and use of under drains can minimize these problems. It is important to divert rain garden overflows to inlets or grass areas in order to prevent deposits of sediment and debris onto parking surfaces.

Forested Areas - In some cases, existing forested areas can be converted to rain gardens by constructing small berms to allow no more than 2 to 4 inches of ponding water. Care must be taken to ensure the existing soils have high infiltration rates (1 inch/hr or higher) and can infiltrate the ponded water in less than 12 hours. Excessive ponding (greater than 24 hours) will adversely affect mature trees which are not tolerant of extreme changes in hydrology. Also, adequate measures must be taken to reduce the erosion potential of directing increased volumes and concentrated flows into existing forested areas.

Fringe Forest Areas - The rain garden can be used for re-vegetation of forest fringe areas to create a forest community and fringe habitat ecosystem. These areas would consist of trees, a sub-canopy of understory trees, a shrub layer, and ground covers. Plants can be selected for their habitat value (food, shelter, and nesting materials).

Open Space Meadows - Areas which are not used for recreation or other purposes can be designed as rain gardens. Where soils and topography allow, wild flower meadow basins can be constructed. Care must be taken to prevent erosion and to disperse flows throughout the bottom of the rain garden basin.

Open Swales - Rain gardens should not be used in the direct flow of an open swale. Since erosion may occur due to high velocities and concentrated flows, rain gardens can be used adjacent to a swale in an off line configuration.



Parking Edge & Perimeter with Curb Figure 7

Landscape Trees - A simple application of a rain garden is to grade shallow depression storage areas around each individual tree. Careful selection of water tolerant trees can allow ponding depths of 2 to 3 inches extending in an 8 to 10 foot diameter around each tree.

Retrofit Existing Areas - Green space and landscaped areas can sometimes be converted to rain gardens. The most convenient areas to retrofit are near existing storm drain inlets. The area adjacent to an inlet can be regraded and landscaped to capture and treat runoff. A good example is the Corkran Middle School case study (page 22) where the courtyard drain was raised about 4 inches to create a shallow storage area around the inlet.

Limitations

Rain gardens relying on infiltration alone for de-watering should not be considered where the water table is within 4 feet of the ground surface and when the surrounding soils are unstable. The practice is also not recommended for areas with steep slopes greater than 25 percent or where mature tree removal will be required.

Long Term Maintenance

Rain gardens require routine periodic maintenance (e.g., mulching, plant replacement, pruning, and weeding) typical of any landscaped area. No special maintenance equipment is needed. Routine maintenance costs will increase proportionally to the number of plants used and area planted. The use of shallow depth under drains will reduce the chance of poor drainage due to clogging and the cost to excavate and replace soils and plant materials.

Cost

Rain garden costs are most attractive when compared to structural practices such as ponds. Cost savings over conventional stormwater practices can vary widely depending on unique site conditions. Savings of 10% to 25% over conventional practices have been achieved in the application of rain gardens to residential, commercial, and industrial sites. They do not require additional space as they are integrated into the existing landscape features. They require some additional costs related to the increased number of plantings, additional soil investigations and under drain systems. The use of meadow rain gardens to replace open space turf will have higher site preparation and plant materials costs but less long term maintenance costs than turf.

Student Participation

Rain gardens are easy to plan, design, and care for. Any of these aspects can be used to develop hands-on participation projects by students and school staff to retrofit schools grounds or to modify or care for existing rain gardens. Since they demonstrate a number of environmental principles, rain gardens are ideal for science studies and projects that demonstrate the hydrologic cycle, impacts of land use on the environment, and the creation of plant and wildlife habitat.

Regulatory Requirements

Regional landscaping and stormwater manuals should be consulted to ensure that the rain garden areas meet the landscaping and stormwater requirements established by the local authorities.